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NAVAL POSTGRADUATE SCHOOL

Monterey, California

THESIS

APPLICATIONS OF ARTIFICIAL INTELLIGENCE
IN VOICE RECOGNITION SYSTEMS
IN MICRO-COMPUTERS

by

Frank Sal Calcaterra

March 1982

Thesis Advisor: G.K. Poock

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Applications of Artificial Intelligence in Voice Recognition Systems in Micro-Computers

by

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Lieutenant Commander, United States Navy
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Submitted in partial fulfillment of the requirements for the degree of

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ABSTRACT

This research investigates the use of inexpensive voice recognition systems hosted by micro-computers. The specific intent was to demonstrate a measurable and statistically significant improvement in the performance of relatively unsophisticated voice recognizers through the application of artificial intelligence algorithms to the recognition software. Two different artificial intelligence algorithms were studied, each with differing levels of sophistication.

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I. INTRODUCTION

A. BACKGROUND

When man's machines progressed from simple tools used for the accomplishment of physical labor to the sophisticated devices of today, capable of "thought like" operations at speeds greatly exceeding that of their creators, the need for new methods of exercising real time control over them also arrived.

1. Voice Recognition

Speech is the most frequently used real time communications interface between two human beings. Barring language or disability difficulties, speech is fast and accurate, and has been the subject of constant training and drill since birth. If one could interface with today's complex machines through the medium of speech, machine operators would not be required to learn the new and intricate control techniques usually necessary for sophisticated operations. These techniques, which are prone to frequent errors, and are inherently slower than speech communications, are frequently a cause of the avoidance of high technology devices by many who are unwilling to learn new control methods. Additionally, a machine operator using voice control methods is free to use his hands and eyes in other ways and may therefore, be a safer worker, less prone to on the job injury (Batchellor,

1980). The interaction of man and machine through the spoken word has been an ardently sought after goal. Ambitious research conducted under the sponsorship of the Defense Advanced Research Projects Agency (DARPA) has clearly indicated that the practical application of "speech understanding" is still out of reach (Erman, 1980). More applicable to today's technology is the non-continuous cousin of speech understanding called "voice recognition". Voice recognition is simply the recognition of certain words or phrases, spoken by a particular speaker, which causes interface hardware and software to initiate some pre-programmed action. One is almost automatically disappointed in the concept of voice recognition when compared to the concept of speech understanding which we are conditioned to expect from popular science fiction movies. However, practical uses for voice recognition exist. Of particular interest are industrial applications where relatively unsophisticated users control industrial processes through the use of simple voice commands.

Given the apparent advantages of voice control, why has the interface between man and his machines depended primarily on a typewriter like keyboard? As available memory and computational speed of modern computer has increased, the introduction of specially designed hardware and carefully engineered software has caused many new attempts at voice recognition to appear.

"Speech recognition technology has advanced to the point where a rapidly increasing number of companies and government agencies are investigating how machines that understand speech fit into their futures." (Lee, 1980).

2. Command, Control, and Communications

The Command, Control, and Communications arena is filled with sophisticated support systems which collect, process, and disseminate information, provide instant point to point communications, and generally assist decision makers in their jobs. Many of these C3 systems are potential hosts for voice control which would allow their operators easier, more rapid, and more accurate access to their functions. Several military command centers are investigating the idea of voice control. Application in the area of Weapons System Control, shipboard Combat Information Center automation, and military (and public) Air Traffic Control are being actively researched. The pilot of a high performance military aircraft could be significantly aided by voice control of non-flight critical systems like weapons assignment and control or communications management. Extensive research in the public sector into the various aspects of voice application is being conducted across the country. There are practical examples of industrial control of production lines and hobbyist automation of the home already available which demonstrate the growing interest in voice technology.

3. Past Studies

Past studies have examined various parameters affecting voice recognition systems. In general, the systems studied were at the upper end of the cost and quality curve. Manufacturers of these systems can now boast of impressive performance statistics for their systems as the result of these past looks at their products. One recent time and accuracy study showed that when subjects had only three hours of training using voice recognition, voice data input was nearly 18% faster than typing and that typing produced greater than 183% more errors (Poock, 1980).

a. "Big Systems"

A "big system" is one that possesses considerable technological sophistication, typically requires a main frame or mini-computer as a host, and, above all, is expensive. Another trait shared by most of the "big systems" is a respectable reliability rate (percentage of correct recognitions as compared to the number of utterances spoken). The "big systems", because of their earlier appearance on the screen, and their acceptable reliability, have received most of the past attention of researchers and experimenters. Indeed, by virtue of their relatively recent introduction, their manufacturers were experimenters themselves.

Considerable work has been done at the U.S. Naval Postgraduate School (NPS) with voice recognition. The typical systems used fell into the category of "big systems". To date,

most have used a mini-computer as a host and have sported a price tag in the $7,000.00 to $20,000.00 range (Lee, 1980). Different studies have examined aspects of voice recognition like basic reliability (percent correct recognitions), the effects of background noise on recognition, the effects of different levels of experience and education on reliability, and even the differences between sexes. In general, all of the studies showed that voice recognition definitely has a place as an input device in future systems. The systems used in these studies boast a reliability in the 95 to 99 percent range. A 1980 NPS study revealed a reliability of 96.8 percent with one popular system (Poock, 1980). Performance such as this is indeed impressive, and has been attractive to the military user who requires high reliability in most applications.

b. "Small Systems"

"Small systems" are less sophisticated than their larger cousins, usually require only an inexpensive microcomputer for a host, and are considerably less expensive. In this "no free lunch" world, the price exacted for the reduction in sophistication and expense lies in system reliability. The "small systems" typically have prices under $2,000.00, and many are in the hands of computer hobbyists that sell for $300.00 to $900.00. The "small systems" advertise reliability rates in the 85 to 95 percent range but have received less attention from serious researchers

because of their vocabulary limitations, lower level of sophistication and more recent introduction (Lee, 1980).

B. APPLICATIONS OF ARTIFICIAL INTELLIGENCE

> "Some researchers believe that intelligent behavior computers can only be produced by a combination of specialized ad hoc tricks (or programming "hacks" as they are often called) and accessing encyclopedic data bases of well indexed facts." (Nilsson, 1971)

Advances in another computer science field, that of Artificial Intelligence, have given cause for voice researchers to reconsider some of the voice recognizers that have lower recognition reliability, but cost considerably less than their more efficient counterparts. Artificial Intelligence programs have made computers skillful game players, have allowed them to "learn" from human masters, and have greatly improved the manner in which large data bases are searched. Could some of these advances be applied to model human sensor techniques and improve the reliability of voice recognizers?

The current hardware/software approach to the voice recognition problem is to divide a word (or utterance) into discrete parts, and measure the various characteristics of those discrete parts. Several repeats of the same word are averaged over time and stored in random access memory (RAM). When a word to be recognized is spoken, it also is divided into discrete parts and characterized. These measurements are compared, in a trial and error fashion, to all the words in the RAM vocabulary, and the closest match is made. The matched vocabulary word is said to have been "recognized".

This processing of sensor data is inherently difficult and is complicated by the ordinary variations in human speech. The search and match procedure can use all of the help that artificial intelligence can offer. As it turns out, no direct method of accomplishing this trial and error search and matching technique has been discovered. Instead, the conventional A.I. approach of limiting the scope of the search (or "pruning") by constructing a list of partial solutions (or best guesses), and then using some function to extend these partial solutions into reasonable answers to be searched in the conventional trial and error manner is required. Hopefully the constructed list of reasonable answers is considerably shorter, and does contain the correct word to be matched. The trick in this approach is to determine the correct function which identifies the reasonable answers. An extension to this approach would enumerate all of the reasonable answers and test them in the context of the problem at hand. This approach requires that the computer be able to discern where it is in the structure of a problem and is therefore only applicable to pre-formatted problems. As it turns out, most voice control problems are reasonably formatted and can be addressed in this manner (Nilsson, 1971).

C. OBJECTIVES

The objective of this thesis is to demonstrate a measurable and statistically significant improvement in the performance of

an unsophisticated and inexpensive voice recognition system by applying artificial intelligence to the existing recognition software, and to demonstrate the applicability of voice control on micro-computers. Specifically, two artificial intelligence programs were designed to increase the percentage of correct recognitions with both experienced and inexperienced users. The programs interact with the commercially supplied software of the recognizer used and, in some cases, deactivate certain of the commercial recognition algorithms in favor of their own. It is also intended to show that artificial intelligence will not degrade the performance of the commercial software and, in fact, become a new step forward in the field of artificial stupidity!

II. METHOD

A. PROGRAM DESIGN

Before attempting to design an experiment to test the effects of artificial intelligence on micro-computer based voice recognition systems, it was necessary to develop the basic A.I. algorithms to be used. No previous work dealing with A.I. applications to speech recognition in systems as small as the current generation of desk top or "personal" computers could be found in research. It was therefore necessary to approach the problem from the most basic level, designing some simple A.I. algorithms and testing for any improvement over the unaugmented commercial software. Rather than attempting the almost certainly unsolvable problem of designing a general algorithm to fit all possible voice recognition situations, it was decided to limit the scope of the problem to certain structured cases which could most easily be adapted to intelligent voice control. An application which could be structured in a "menu tree" was chosen for ease of demonstration. It should be noted that a vast majority of control techniques within the military Combat Systems arena fit into the category of "menu tree" structure. That is to say, the choosing of some control option almost certainly leads to several sub-options which, in turn, probably cascade down into further sub-options. The "menu

tree" used in the A.I. algorithms was specifically designed for this application (see Appendix A). It was structured to simulate the use of an automated threat library that might be used by a shipboard Tactical Action Officer (TAO).

Ultimately, two A.I. algorithms were designed: one which was intended to provide a low level of A.I. support to the commercial voice recognition software used, and one which provided almost all selection of the recognized word through A.I. and, in fact, deactivated many of the commercial recognition algorithms in favor of its own. As might be predicted, the first algorithm operated considerably faster than the second. Speed of operation was not considered as a factor in testing the effects of A.I. but should be considered in follow-up experimentation.

1. Algorithm One (Limited A.I.)

The first A.I. algorithm was to augment the commercial recognition routines by keeping track of where the operator was in the structured "menu tree". This allowed the algorithm to "expect" certain answers. When the commercial routines selected an utterance as "recognized", that utterance was examined in the context of the question at hand. Simply stated, if the only possible selection at a particular stage of the program were "aircraft", "ships", and "submarines", and the recognition routines returned "yellow" as the recognized word, it would be dismissed as a possibility, and the search for another word match would continue. In this manner,

the A.I. algorithm was "expecting" one of the correct word matches for that level of the "menu tree", and the recognition routines could effectively disregard other vocabulary entries. The incorrect recognition of a word which was on the "expected" list could not be prevented. It was expected that the incidence of such incorrect but "expected" recognitions would be small. Algorithm One is included as Appendix B.

2. Algorithm Two (Enhanced A.I.)

The second A.I. algorithm developed was designed to make use of all of those techniques available in a machine of limited memory size and comparatively slow speed of operation. The second algorithm included the "expectation" functions of the first. That is, it was able to keep track of the current position within the "menu tree", and would "expect" only the responses possible in the context of that position. In addition to "expectation", the second program included a complete enumeration of all likely answers without regard to context. It performed this function by deactivating the commercial recognition algorithms and used only the purely mathematical evaluation function. This function assigned numerical weighting to each word in the RAM vocabulary based on how closely it compared to the spoken word recognized. Instead of returning a recognized word for context checking by the first A.I. algorithm, the three best words were returned, each to be checked in context. If any or all of the three returned words were "expected", the highest weighted (and

expected) word was accepted. If none of the words were "expected", the evaluation process was repeated. (For the purpose of experimentation, the three selected words were displayed prior to returning to the evaluation process).

The second algorithm was still subject to errors occurring when an incorrect but "expected" recognition was made. Algorithm Two is included as Appendix C.

B. EXPERIMENTAL DESIGN

The experiment was designed to test the two A.I. algorithms as a three way factorial analysis of variance with one data point per cell. The test group trained on the commercial system and then tested each of the algorithms using the same "menu tree" structure and scenario. The test data, therefore, became related samples, paired in the sense that each observation in one test was associated by structure and subject with an observation in the other test. Additional comparison to an earlier experiment done to establish a reliability baseline was made. That experimental test group and the group used in this experiment were independent, both in composition and test structure (i.e. the "menu tree" was not used in the earlier base line experiments).

C. SUBJECTS

Ten volunteers participated in this study. They were all from the "NPS community" in that they were either career military officers enrolled at NPS, or they were spouses of

students. There were five male military officers, all graduate students in the Command, Control, and Communications or Aeronautical Engineering curricula. Of the five, two were Navy, two were Army, and one was Air Force; four had previous voice experimentation experience; all were pursuing a Master's Degree in a technical field. There were also five civilian females (all spouses of NPS students). Of the females, only one had any experience which may have contributed to her performance, but that experience was with aircraft radio communications as a private pilot rather than voice recognition. Based on a verbal interview, all of the females believed voice recognition would be accurate while most of the males were skeptical. Their skepticism appeared to be based on their perception of the limitations inherent in the micro-computer rather than on voice recognition technology.

D. EQUIPMENT

The equipment used in this experiment can be divided into two independent parts, the host micro-computer and supporting devices, and the voice recognition equipment. This particular equipment was chosen based upon availability and ease of operation. The thesis was intended to prove a concept and should not be considered a recommendation for one particular brand of equipment.

1. The Micro-Computer

The host micro-computer chosen for the experiment was an Apple Computer Incorporated, Apple-II Plus personal

computer with 48k of internal RAM. It was supported by two Apple Computer Incorporated, Disk-II mini-floppy disk drives for mass storage, and an NEC 12 inch green phosphor display tube. Software support for the micro-computer included Apple Computer's Applesoft language (a version of BASIC), and Disk Operating System (DOS). Additional software support was provided by the author.

The host micro-computer recalls previously recorded voice recognition templets (or vacabularies) from a diskette and provides all comparison and matching processing for the recognition hardware. Additionally, it provides an isolated and independent area of RAM for the management and execution of the experimental program. Once the particular speaker's voice templet and the experimental program are loaded into RAM, no further disk accesses are required.

2. The Voice Recognizer

The voice recognizer used was the Scott Instruments Incorporated, Voice Entry Terminal II (VET-II). The VET-II consists of a hardware preprocesser and a software driving routine. The preprocesser analyzes an acoustic signal within the 300 Hz to 4000 Hz range by dividing the frequency package into two regions (300-1000 Hz and 1000-4000 Hz) and taking "zero-crossing" measures and extracting amplitude envelopes in both regions. These four measurements are converted to digital representations and fed to the host computer. The control software requires about 6000 bytes of RAM while the

average voice templet requires about 4600 bytes of RAM, for a total memory requirement not to exceed 10.6K of RAM from the host (Scott Instruments, 1981).

The VET-II applies the four measurements discussed above to those of the vocabulary stored in memory and assigns each word a numerical value, the lower the number the closer the match between the word being processed and a particular stored vocabulary word. Additional processing precludes selection if the number of syllables of the word being processed does not match the number of syllables of the vocabulary word. Additional constraints preclude selection of any word if there is "tie" (defined as a second word assigned a value within a spread of 20 units from the word selected), or if no word receives a recognition value below 200 units. These parameters are controlled by the software provided with the VET-II, and can be changed by an enterprising programmer.

The VET-II will accept up to forty words per vocabulary templet set. Each word is actually an utterance that may be comprised of any number of words not exceeding 1.5 seconds in total duration. Previous experiments conducted at NPS concluded that there was no measurable difference in the number of correct recognitions when the vocabulary in memory was increased from 20 to 40 utterances (Poock, 1980).

E. PROCEDURE

The experimental procedure was easily broken into two distinguishable parts:

1. Training

Each operator was required to "train" the voice recognizer with the words he was to use during operation. Training is the process by which the user creates a voice templet of his speech patterns for the words to be used. Training may be accomplished by repeatedly pronouncing each word or by saying the words in response to a random prompt from the training routine provided with the VET-II. Experiments conducted at NPS indicate that the random prompted training technique provided the best results and that was the technique used in this experiment (Poock, 1980). Training took place during two consecutive sessions. Each session consisted of three runs of the prompted training program, resulting in three "training passes". After the two training visits, each subject had a voice templet consisting of the average of six utterances of each word (or phrase). In several instances, when the subject had made detectable mistakes during a training session, the word in question was retrained using three to six consecutive training passes. No records were kept of these infrequent aberrations to the prompted training technique and they are considered significant.

2. The Experiment

The experiment consisted of reading through the structured "menu tree" as if accessing tactical information from a data bank. Each run followed the same pattern. The procedure was done one time for each of the two A.I. approaches at a sitting. Since there was no practical way to hide the different algorithms (one being much faster than the other), they were simply alternated so that neither was always first or last. Subject knew only that they were using the faster or the slower of two different voice recognition algorithms. During each run the number of mis-recognitions and the number of non-recognitions were recorded. A non-recognition occurred when the system failed to select a word (in program one, when the "expected" word was not returned; in program two, when no word which was a "likely" match fit in context). Non-recognitions were called 'x - errors'. A mis-recognition occurred when the system incorrectly selected a word as "matching" the spoken word. In each program this incorrect word would also have to pass context tests, and in program two, it would have had to fall in the top three "most likely" matches. These errors were called 'y - errors'.

F. DATA

Each subject (with one exception) ran the experiment ten times for each A.I. program. These two sets of ten data points were reduced into averages for each subject over each

program. The data generated from these data points is reflected in the various charts and graphs in Chapter III.

Data from a previous experiment was used to establish a reliability baseline figure for the system configuration without A.I. augmentation. That data was collected in a controlled experiment with both male and female, military and civilian, experienced and non-experienced users (Poock, 1980).

III. DATA ANALYSIS AND RESULTS

The data collected in this experiment was used to determine if any significant improvement was gained in the percentage of correct recognitions of the VET-II voice recognizer system through the application of various degrees of artificial intelligence. Before one could make any meaningful comment concerning the differences between the A.I. programs, (the Program Two, with enhanced A.I. capabilities as opposed to Program One, with limited A.I. capabilities), one had to demonstrate an increased reliability when using any form of A.I. support vs an unaugmented recognizer. With that thought in mind, the analysis procedures were broken into two separate areas; the first comparing each of the A.I. programs against data from an earlier experiment using the same VET-II recognizer and APPLE computer in an unaugmented state; the second, comparing the two A.I. programs developed for this thesis. In addition, it was considered necessary to examine the results of both A.I. programs vs the unagmented system using a more limited population; experienced users, and inexperienced users. It was felt that a demonstrated increase in the performance of inexperienced users when using either of the A.I. programs may have been more important in the context of eventual mass use of voice recognition than say, an improvement in the reliability figures for experienced users only.

A. HYPOTHESES

1. The Baseline

Each of the A.I. programs was compared, in turn, to the data recorded in an experiment conducted in mid 1981 at NPS (Poock, 1980).

a. The Baseline vs Program One

It was decided to test the hypothesis that there was no difference between the baseline data and Program One's data against the alternate hypothesis that there was indeed a measurable difference between the two. A T-TEST for independent samples was performed as discussed in Ya-Lun Chow's Statistical Analysis.

b. The Baseline vs Program Two

Again the hypothesis that there was no difference between the baseline data and Program Two's data was tested against the alternate hypothesis that there was a measurable difference. The same T-TEST for independent samples was used.

c. The Smaller Samples

In each case above, the data for experienced and inexperienced users was compared. In every case, because of the small sample size, the Mann-Whitney U Test was used (Siegel, 1956). The hypothesis that there was no difference between a particular group in an A.I. program and in the baseline data was tested against the alternate hypothesis that there was a measurable difference.

2. <u>Comparison of Limited vs Enhanced A.I. Programs</u>

The comparison between the two A.I. programs considered percentage of correct recognitions only, no effort was made to analyze the time required for recognition. It should be noted however, that the second program was significantly slower than the first, and caused noticeable boredom in the test subjects.

Since the same subjects were used in the experiments for each of the A.I. programs, and since there were an equal number of experimental runs (hence an equal number of data points), it was decided to use the T-TEST for matched pairs with related samples (Chou, 1980). Table I shows the data collected for Program One, while Table II shows the data collected for Program Two. Figure 1 shows a graph of the ten experimental runs vs percentage of correct recognitions over all subjects, and may be considered a representation of the limited effect of learning in this experiment. Because the T-TEST reflects only each subject's average performance over ten experimental runs, the T-TEST was confirmed using an analysis of variance between the two programs over all subjects and all runs. The data was transformed using an arcsine transform for convenience. The structure of the ANOVA is shown in Figure 2. In each test, the hypothesis that there was no difference between the two programs was tested against the alternate hypothesis that there was indeed a measurable difference.

TABLE I

EXPERIMENTAL PROFILE - PROGRAM ONE

SUBJECT	NR SPK	ERR-X	ERR-Y	ERR SUM	REL %	NR 1ST
1 (F/N)	301	31	6	37	87.7	NA
2 (M/X)	293	23	15	38	87.03	NA
3 (F/N)	326	57	5	62	80.98	NA
4 (M/X)	295	25	10	35	88.13	NA
5 (M/X)	301	31	8	39	87.04	NA
6 (F/N)	282	11	9	20	92.9	NA
7 (F/N)	286	15	7	22	92.3	NA
8 (M/N)	292	22	11	33	88.69	NA
9 (M/X)	203	14	10	24	88.17	NA
10 (F/N)	285	17	2	19	93.33	NA
TOTALS	2864	246	83	329	88.51	NA
MEAN = 88.63		VAR = 13.19		STD DEV = 3.63		
TOTAL (X)	1092	93	43	136	87.59	NA
TOTAL (N)	1772	153	40	193	89.[illegible]2	NA

NOTES: NR SPK = NUMBER OF WORDS SPOKEN.
REL % = PERCENT CORRECT RECOGNITION (RELIABILITY).
ERR-X = NON-RECOGNITION ERROR.
ERR-Y = MIS-RECOGNITION ERROR.
(M/) = MALE SUBJECT.
(F/) = FEMALE SUBJECT.
(/X) = EXPERIENCED SUBJECT.
(/N) = INEXPERIENCED SUBJECT

TABLE II

EXPERIMENTAL PROFILE - PROGRAM TWO

SUBJECT	NR SPK	ERR-X	ERR-Y	ERR SUM	REL %	NR 1ST
1 (F/N)	272	2	29	31	88.6	249
2 (M/X)	270	0	29	29	89.25	251
3 (F/N)	270	0	26	26	90.37	241
4 (M/X)	276	6	17	23	91.66	252
5 (M/X)	278	7	15	22	92.08	258
6 (F/N)	270	0	17	17	93.7	249
7 (F/N)	273	3	14	17	93.77	253
8 (M/N)	272	2	16	18	93.38	253
9 (M/X)	193	4	17	21	89.11	167
10 (F/N)	272	2	9	11	95.95	256
TOTALS:	2646	26	189	215	91.87	2429

MEAN = 91.79 VAR = 5.93 STD DEV = 2.43

PERCENT OF WORDS CHOSEN ON FIRST ATTEMPT = 91.79894

TOTAL (X)	1017	17	78	95	90.53
TOTAL (N)	1629	9	111	120	92.63

NOTES: NR SPK = NUMBER OF WORDS SPOKEN.
REL % = PERCENT CORRECT RECOGNITION (RELIABILITY).
ERR-X = NON-RECOGNITION ERROR.
ERR-Y = MIS-RECOGNITION ERROR.
(M/) = MALE SUBJECT.
(F/) = FEMALE SUBJECT.
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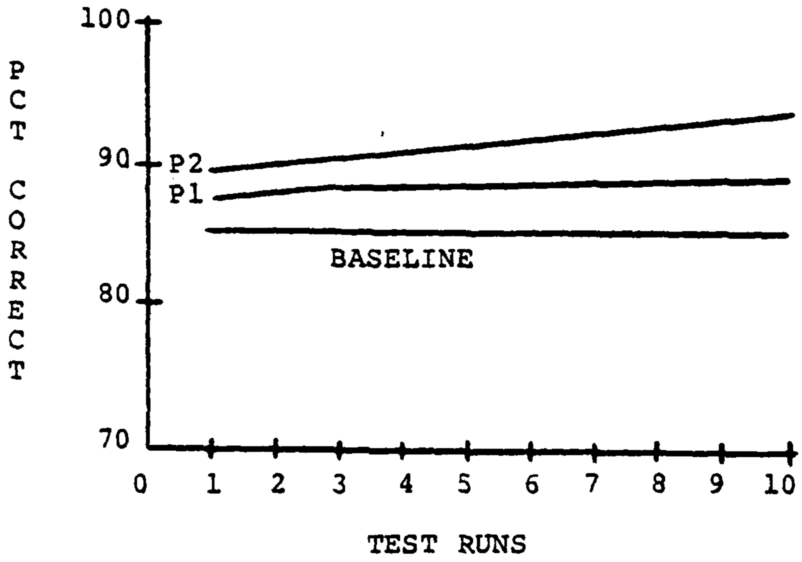
(/N) = INEXPERIENCED SUBJECT.



Notes: The curve for Program One (P1) most closely resembles a logarithmic curve indicating that the effect of learning on the performance of the subjects is larger in the beginning of the experiment, and becomes less as the subject gains experience. The curve may be represented by the equation $y=87.56+(0.87)\ln(x)$.

The curve for Program Two (P2) is linear, indicating that the subjects have not yet reached the maximum advantage of learning. The curve may be represented by the equation $y=89.04+(0.53)x$.

The effect of learning is small in both cases, and does not contribute significantly to the average subject's performance.

Figure 1. Graph of Learning Curve.

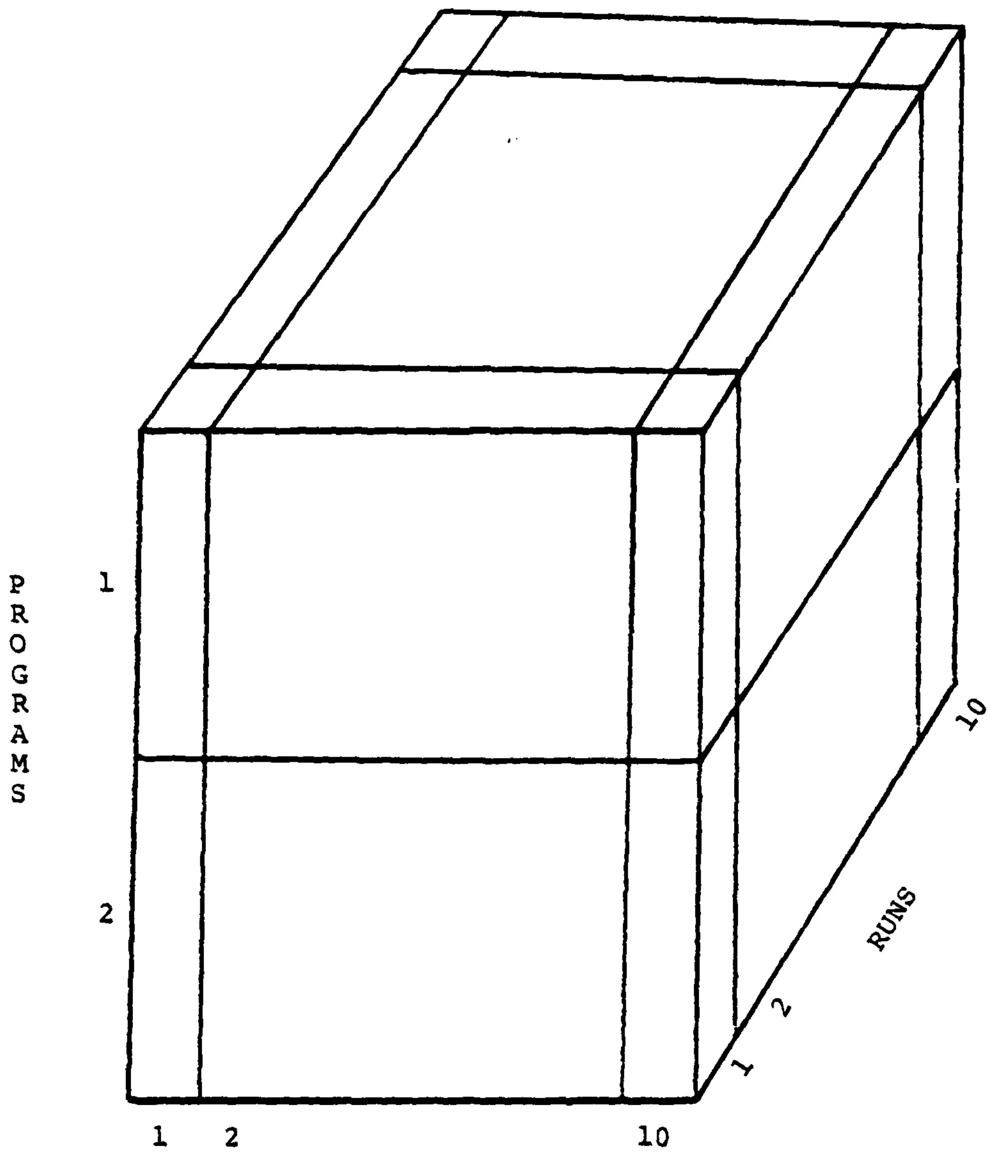


Figure 2. ANOVA Structure

3. Tabular Review

All of the hypotheses discussed above are more succinctly displayed in Table III.

B. RESULTS

1. The Baseline

Baseline statistics for the VET-II recognizer were established during an earlier experiment. When averaging the percentage of correct recognitions over all subjects using the same training technique as was employed in the A.I. experiment, one finds that the Scott system produced 84.63 percent correct recognitions. A complete listing of baseline data is shown in Table IV.

a. The Baseline vs Program One

The performance of Program One (employing limited A.I.), when averaged over all subjects and runs, was 88.51 percent correct recognitions. The program worked quickly enough that no difference between augmented and unaugmented operation could be detected in the Scott recognizer. A complete listing of data for Program One is shown in Table V.

When tested against the baseline at a significance level (alpha) of 0.05, the T-TEST test statistic (2.002) fell within the acceptance region of -2.145 to +2.145, and therefore the hypothesis that there was no difference between Program One and the baseline could not be rejected. It should be noted however, that when tested at alpha = 0.10, the test statistic fell comfortably outside of the acceptance region of

TABLE III

TABULAR REVIEW

Comparison	Hypothesis	Alt Hypothesis
Baseline vs. Program One	No Difference	Difference
Baseline vs. Program Two	No Difference	Difference
Baseline vs. Program One Experienced	No Difference	Difference
Baseline vs Program One Inexperienced	No Difference	Difference
Baseline vs Program Two Experienced	No Difference	Difference
Baseline vs Program Two Inexperienced	No Difference	Difference
Program One vs Program Two	No Difference	Difference

TABLE IV

BASELINE DATA

SUBJECT	REL %
1 (F/N)	81.6
2 (F/X)	88.8
3 (F/N)	82.7
4 (M/X)	91.2
5 (F/N)	82.4
6 (M/N)	81.1

AVE = 84.63 MEAN = 84.63
VAR = 18.18 STD DEV = 4.26

NOTES: REL % = PERCENT CORRECT RECOGNITIONS.
(M/) = MALE SUBJECT.
(F/) = FEMALE SUBJECT.
(/X) = EXPERIENCED.
(/N) = INEXPERIENCED.

From Poock (1980)

TABLE V

T-TEST FOR INDEPENDENT SAMPLES
PROGRAM NR 1 AND BASELINE DATA

SUBJECT	PROG 1	BASELINE DATA
1	87.7	81.6
2	87.03	88.8
3	80.98	82.7
4	88.13	91.2
5	87.04	82.4
6	92.9	
7	92.3	
8	88.69	
9	88.17	
10	93.33	
AVE =	88.51	84.63
MEAN =	88.63	84.63
VAR =	13.19	18.18
STD DEV =	3.63	4.26
N =	10	6

HYPOTHESIS: NO DIFFERENCE
ALPHA = 0.10
ACCEPT REG = (-1.767<TS<+1.767)
TS = 2.001860
(REJECT HYPOTHESIS)

-1.767 to +1.767, and therefore the hypothesis that there was no difference between the Program One and the baseline could be rejected.

It is not surprising to find that there is an apparent trend toward improvement with Program One, but that the trend is not dramatic. Program One, after all, does not represent a large modification over the commercial recognizer algorithms. The concept of expectation will not reject an answer that is obviously wrong, but fits in context.

b. The Baseline vs Program Two

The performance of Program Two (employing enhanced A.I.), when averaged over all subjects and runs, was 91.80 percent correct recognitions. As previously mentioned, the program functioned slowly enough to be distracting. A complete listing of data for Program Two is shown in Table VI.

When tested against the baseline at alpha = 0.05, the test statistic (4.319) fell well outside of the acceptance region of -2.145 to +2.145 and therefore, the hypothesis that there was no difference between Program Two and the baseline could be rejected.

Again, it is not surprising to find that the program containing extensive artificial intelligence aids to the recognition process produced better performance.

c. The Smaller Samples

The results for the Mann-Whitney U Tests for the experienced and inexperienced users for both programs yielded

TABLE VI

T-TEST FOR INDEPENDENT SAMPLES
PROGRAM NR 2 AND BASELINE DATA

SUBJECT	PROG 2	BASELINE DATA
1	88.6	81.6
2	89.25	88.8
3	90.37	82.7
4	91.66	91.2
5	92.08	82.4
6	93.7	
7	93.77	
8	93.38	
9	89.11	
10	95.95	

AVE =	91.87	84.63
MEAN =	91.79	84.63
VAR =	5.93	18.18
STD DEV =	2.43	4.26
N =	10	6

HYPOTHESIS: NO DIFFERENCE
ALPHA = .05
ACCEPT REG = (-2.145 < TS < +2.145)
TS = 4.319213
(REJECT HYPOTHESIS)

some interesting data. In each case an alpha = 0.10 was used. Complete data is shown in Table VII.

(1) Experienced Users. The experienced speaker using Program One demonstrated a better correct recognition rate than the baseline figure (87.59% vs 84.63%) at the 0.10 level. No such improvement could be verified at the 0.10 level for the experienced users in Program Two vs. the baseline although their purely arithmetic averages were higher (90.53 vs 84.63). The structure of the Mann-Whitney U Test, employing the ranked order of scores, simply could not confirm a significant difference between Program Two and the baseline at the 0.10 level.

(2) Inexperienced Users. The inexperienced speaker using Program One demonstrated a better correct recognition rate than the baseline figure (89.32% vs 84.63%) at the 0.10 level. The same result was observed in Program Two (92.63 vs 84.63). Again the order ranking determined that there was a measurable difference between the A.I. programs and the baseline.

The improvement in the performance of inexperienced speakers shall be addressed in more detail in the next chapter.

2. Limited A.I. vs Enhanced A.I.

The percentage of correct recognitions, averaged over all subjects and runs, for Program One (limited A.I.) was 88.51 while Program Two (enhanced A.I.) was 91.87. The

TABLE VII

MANN-WHITNEY U TEST (SMALL N'S)
PROG-1 VS BASELINE DATA
EXPERIENCED USERS

SUBJECT	PROG 1	BASELINE
(1/2)	87.03	88.8
(4/4)	88.13	91.2
(5)	87.04	
(9)	88.1	

RANKED ORDERED SETS
1/1/1/1/B/B

U = 0 P = 0.067
N1 = 2 ALPHA = 0.10
N2 = 4

HO: NO DIFFERENCE (REJECT)

MANN-WHITNEY U TEST (SMALL N'S)
PROG-1 VS BASELINE DATA
INEXPERIENCED USERS

SUBJECT	PROG 1	BASELINE
(1/1)	87.7	81.6
(3/3)	80.98	82.7
(6/5)	92.9	82.4
(7/6)	92.3	81.1
(8)	88.69	
(9)	93.33	

RANKED ORDERED SETS
1/B/B/B/B/1/1/1/1/1

U = 4 P = 0.057
N1 = 4 ALPHA = 0.10
N2 = 6

HO: NO DIFFERENCE (REJECT)

MANN-WHITNEY U TEST (SMALL N'S)
PROG-2 VS BASELINE DATA
EXPERIENCED USERS

SUBJECT	PROG 2	BASELINE
(1/2)	89.25	88.8
(4/4)	91.66	91.2
(5)	92.08	
(9)	89.11	

RANKED ORDERED SETS
B/2/2/B/2/2

U = 2 P = 0.267
N1 = 2 ALPHA = 0.10
N2 = 4

HO: NO DIFFERENCE (CANNOT REJECT)

MANN-WHITNEY U TEST (SMALL N'S)
PROG-2 VS BASELINE DATA
INEXPERIENCED USERS

SUBJECT	PROG 2	BASELINE
(1/1)	88.6	81.6
(3/3)	90.37	82.7
(6/5)	93.7	82.4
(7/6)	93.77	81.1
(8)	93.38	
(9)	95.95	

RANKED ORDERED SETS
B/B/B/B/2/2/2/2/2/2

U = 0 P = 0.005
N1 = 4 ALPHA = 0.10
N2 = 6

HO: NO DIFFERENCE (REJECT)

T-Test for matched pairs yielded a test statistic of -3.736, well outside of the acceptance region of -2.262 to +2.262 at the 0.10 level. The hypothesis that there was no difference between the two programs was rejected.

The fact that the enhanced A.I. program yielded better results than its less sophisticated cousin with limited A.I. came as no surprise. Complete data for the matched pairs is shown in Table VIII.

As previously mentioned, the comparison of the two A.I. programs was confirmed using an ANOVA. The results supported the T-TEST for matched pairs, and may be considered a more accurate reflection of the comparison. The ANOVA results are shown in Table IX.

3. Additional Information

It has been mentioned that Program Two presents the expectation algorithm with the three "most likely" matches for the word being processed, and that they are then tested in context of the menu position currently being executed. It was considered likely that the word eventually matched would be the first of the three "most likely" choices .. or the "most likely" of the "most likely". The small memory size of the host computer did not allow routines to track the number of times the matched word (correct and incorrect) was number one, two, or three, of the "most likely". The only available figure, more easily tracked in the program, was the number of times the first "most likely" utterance was

TABLE VIII

T-TEST BETWEEN MATCHED PAIRS

SUBJECT	PROG 1	PROG 2	Δ	Δ^2
1	87.7	88.6	- .9	.81
2	87.03	89.25	- 2.22	4.9284
3	80.99	90.37	- 9.38	87.9844
4	88.13	91.66	- 3.53	12.4609
5	87.04	92.08	- 5.04	25.4016
6	92.9	93.7	- .8	.64
7	92.3	93.77	- 1.47	2.1609
8	88.69	93.38	- 4.69	21.9961
9	88.17	89.11	- .94	.8836
10	93.33	95.95	- 2.62	6.8644
TOTALS:	886.28	917.87	-31.59	164.1303

HYPOTHESIS: NO DIFFERENCE BETWEEN THE PROGRAMS

ALPHA = 0.05

TEST STAT (TS) = -3.73627

ACCEPTANCE REGION = (-2.262<TS<2.262)

(REJECT HYPOTHESIS)

D-BAR = -3.159

S-HAT (D) = 2.673688

SIGMA-HAT (D) = .8454945

TABLE IX

ANALYSIS OF VARIANCE

Source	DF	SS	MS	F	Sig
Programs	1	0.484	0.484	7.33	<0.05
Subjects	9	2.429	0.270	6.98	<0.01
Runs	9	0.988	0.111	1.79	<0.10
Prog x Subj	9	0.592	0.066	1.71	<0.10
Prog x Runs	9	0.448	0.050	1.29	N.S.
Subj x Runs	81	5.041	0.062	1.60	<0.05
Error	81	3.135	0.037		
Totals	199	13.127			

DF = Degrees of Freedom MS = Mean Square Sig = Prob of Error

SS = Sum of Squares F = F Ratio

the same as the utterance selected by the commercial software prior to being suppressed by the A.I. routines. This figure, 2429 out of a possible 2646, represented 91.798 percent of the time.

Although more research is required in this area, one must evaluate the percentage of first selections against the time required to process the second and third selections. This will obviously become a reliability vs speed of execution trade-off. One must also consider the increased possibilities of error resulting from consideration of a second or third choice.

IV. DISCUSSION AND CONCLUSIONS

The results discussed in the preceding chapter have demonstrated that there is an advantage to be gained in the voice recognition process by the judicious application of artificial intelligence to existing recognition routines. There appears to be a direct relation between the sophistication of the A.I. routines and the increase in the percentage of correct recognitions by the system. Certainly not all possible A.I. routines have been experimented with; however, sufficient proof has been gathered to support the claim that A.I. in general is suitable for application in the voice recognition problem.

The inexperienced user appeared to gain more than the experienced user through the A.I. routines. Although it is disappointed not to be able to show an improvement for experienced speakers using Program Two vs the baseline, it is more significant that an improvement may be shown for the inexperienced user. As recognition systems are introduced throughout the Navy, there undoubtedly will be more inexperienced users than experienced ones. Continued research with A.I. augmented voice recognition routines can be expected to improve recognition reliability.

It is an encouragement to show that small micro-computers are capable of competing with their larger brothers. The

small system typified by the one used in this experiment is more accessable to the general population of this country than any of the more sophisticated computers in use or under development. Most of the subjects, and all of the inexperienced ones, found the micro-computer less intimidating than "real computers". Such reactions would ease the introduction of micro-computer based data banks accessed by voice control.

The TAO information simulated in these experiments can be increased in scope and content and applied to a shipboard environment without excessive expenditures for hardware or long unsure waiting for advances in technology. Micro-computer based voice control systems can function reliably and their cost is dramatically less than the sophisticated systems currently being examined. Their simple construction and multiple secondary uses should not be overlooked. Even their growing popularity among hybbyists would assist in making their introduction less difficult. Today's destroyer Combat Information Center (CIC) watch standers could make good use of the time and effort saved by accessing a small data base management system (DBMS) controlled by voice when a review of tactical information was necessary. These principal watch standers are always busy, and usually have their hands occupied with plots, radios, or tactical systems. A voice actuated DBMS would allow them to obtain the information they need on a moments notice without requiring that they abandon the task currently occupying them.

APPENDIX B

THE MENU TREE

Main Menu

Aircraft Menue
Surface Menu
Submarine Menu
Main Menu
Abort

Aircraft Menue	Surface Menu	Submarine Menu
Aircraft	Ships	Submarines
Aircraft Weapons	Surface Weapons	Submarine Weapons
Profiles	Profiles	Profiles
Main Menu	Main Menu	Main Menu
Go Back	Go Back	Go Back
Abort	Abort	Abort

Aircraft	Ships	Submarines
Alpha	Alpha	Alpha
Bravo	Bravo	Bravo
Charlie	Charlie	Charlie
Delta	Delta	Delta
Main Menu	Main Menu	Main Menu
Go Back	Go Back	Go Back
Abort	Abort	Abort

Aircraft Weapons	Surface Weapons	Submarine Weap.
(not implemented)	(not implemented)	(not imp.)

Profiles	Profiles	Profiles
(not implemented)	(not implemented)	(not imp.)

Notes:

1) Utterances not used: (first name), (last name), and (experience) are variable in each templet, but are always precluded from recognition by software patch.

APPENDIX B

PROGRAM ONE (LIMITED A.I.)

```
110    REM      VET INTERFACE PACKAGE

120    REM      ---------------------

130    GOSUB 3820
     : REM  VET INITIALIZE

140    CALL JTABLE + 15

150    REM     GOTO 240 SKIPS LOAD

160    HOME
     : VTAB 10

170    INPUT "VOICE FILE NAME ... ";VOC$

180    GOSUB 3880
     : REM      READ VOICE FILE

190    SYN$ = "2X"
     : REM      TURN OFF X-WORDS

200    GOSUB 3970
     : REM      EXECUTE SYN$ ABOVE

210    REM  END VET INTERFACE PACK

220    REM  ---------------------

230    REM

240    REM

250    REM  F.S.CALCATERRA 12/10

260    REM  ====================

270    REM

280    REM  -------------------

290    REM  * MAIN MENU MODULE *

300    REM  -------------------

310    REM

320    REM  MAIN MENU
```

```
330   REM  ---------

340   TEXT
    : HOME
    : POKE 44611,1

350   PRINT "F.S. CALCATERRA"; SPC( 8);"THESIS DISK #001"

360   FOR I = 1 TO 38
    :   PRINT ".";
    : NEXT I
    : PRINT "."

370   POKE 34,2

380   HOME
    : VTAB 5
    : HTAB 14

390   PRINT "MAIN MENU"

400   FLAG$ = "MAIN MENU"
    : LFLAG$ = "NULL"

410   HTAB 14
    : PRINT "---------"

420   PRINT
    : HTAB 14
    : PRINT "AIRCRAFT MENU"

430   PRINT
    : HTAB 14
    : PRINT "SURFACE MENU"

440   PRINT
    : HTAB 14
    : PRINT "SUBMARINE MENU"

450   GOSUB 3220
    : REM  INPUT DISPLAY SUB

460   GOSUB 3700
    : REM  ANS SUB

470   GOTO 490

480   STOP

490   REM  MAIN MENU A/I PACK

500   REM  -----------------
```

```
510   FOR I = 1 TO 3
520     IF ANS$(I) = "AIRCRAFT MENU" THEN 610
530     IF ANS$(I) = "SURFACE MENU" THEN 1450
540     IF ANS$(I) = "SUBMARINE MENU" THEN 2290
550     IF ANS$(I) = "GO BACK" THEN 3590
560     IF ANS$(I) = "ABORT" THEN 3150
570     IF ANS$(I) = "MAIN MENU" THEN 320
580   NEXT I
590   GOTO 3350
    : REM  ERROR PACK
600   STOP
610   REM  AIR MENU
620   REM  --------
630   HOME
    : VTAB 5
    : HTAB 14
    : PRINT "AIRCRAFT MENU"
640   LFLAG$ = FLAG$
    : FLAG$ = "AIRCRAFT MENU"
650   HTAB 14
    : PRINT "-------------"
660   PRINT
    : HTAB 14
    : PRINT "ATTACK AIR"
670   PRINT
    : HTAB 14
    : PRINT "AIR WEAPONS"
680   PRINT
    : HTAB 14
    : PRINT "PROFILES"
690   GOSUB 3220
    : REM  INPUT DISP SUB
```

```
700   GOSUB 3700
     : REM  ANS SUB

710   GOTO 730

720   STOP

730   REM  AIR A/I PACK

740   REM  ------------

750   FOR I = 1 TO 3

760     IF ANS$(I) = "ATTACK AIR" THEN 850

770     IF ANS$(I) = "AIR WEAPONS" THEN 1350

780     IF ANS$(I) = "PROFILES" THEN 1400

790     IF ANS$(I) = "MAIN MENU" THEN 320

800     IF ANS$(I) = "ABORT" THEN 3150

810     IF ANS$(I) = "GO BACK" THEN 3590

820   NEXT I

830   GOTO 3350
     : REM  ERROR PACK

840   STOP

850   REM  AIRPLANES MENU

860   REM  --------------

870   HOME
     : VTAB 5
     : HTAB 13
     : PRINT "ATTACK AIRCRAFT"

880   LFLAG$ = FLAG$
     : FLAG$ = "ATTACK AIR"

890   HTAB 13
     : PRINT "---------------"

900   PRINT
     : HTAB 13
     : PRINT "ALPHA  - BADGER"

910   PRINT
```

```
    : HTAB 13
    : PRINT "BRAVO - BEAR"

920   PRINT
    : HTAB 13
    : PRINT "CHARLIE - BLINDER"

930   PRINT
    : HTAB 13
    : PRINT "DELTA - BACKFIRE"

940   GOSUB 3220
    : REM  INPUT DISP SUB

950   GOSUB 3700
    : REM  ANS SUB

960   GOTO 980

970   STOP

980   REM  ATTAIR A/I PACK

990   REM  ---------------

1000  FOR I = 1 TO 3

1010     IF ANS$(I) = "ALPHA" THEN 1110

1020     IF ANS$(I) = "BRAVO" THEN 1170

1030     IF ANS$(I) = "CHARLIE" THEN 1230

1040     IF ANS$(I) = "DELTA" THEN 1290

1050     IF ANS$(I) = "MAIN MENU" THEN 320

1060     IF ANS$(I) = "ABORT" THEN 3150

1070     IF ANS$(I) = "GO BACK" THEN 3590

1080  NEXT I

1090  GOTO 3350
    : REM  ERROR PACK

1100  STOP

1110  REM  BADGER DISPLAY

1120  REM  --------------
```

```
1130  HOME
    : VTAB 12
    : HTAB 14
    : PRINT "BADGER DATA"

1140  GOSUB 3290
    : REM  HOLD SUB

1150  GOTO 850

1160  STOP

1170  REM  BEAR DISPLAY

1180  REM  ------------

1190  HOME
    : VTAB 12
    : HTAB 14
    : PRINT "BEAR DISPLAY"

1200  GOSUB 3290
    : REM  HOLD SUB

1210  GOTO 850

1220  STOP

1230  REM  BLINDER DISPLAY

1240  REM  ---------------

1250  HOME
    : VTAB 12
    : HTAB 13
    : PRINT "BLINDER DISPLAY"

1260  GOSUB 3290
    : REM  HOLD SUB

1270  GOTO 850

1280  STOP

1290  REM  BACKFIRE DISPLAY

1300  REM  ----------------

1310  HOME
    : VTAB 12
    : HTAB 12
    : PRINT "BACKFIRE DISPLAY"
```

```
1320  GOSUB 3290
    : REM      HOLD SUB

1330  GOTO 610

1340  STOP

1350  REM  AIR ASCM MENU

1360  REM  ------------

1370  MARK$ = "AIR ASCM"
    : GOSUB 3490
    : REM  NOT  IMP  SUB

1380  GOTO 610

1390  STOP

1400  REM  AIR PROFILE MENU

1410  REM  ----------------

1420  MARK$ = "AIR PROFILES"
    : GOSUB 3490
    : REM  NOT  IMP  SUB

1430  GOTO 320

1440  STOP

1450  REM  SURFACE MENU

1460  REM  ------------

1470  HOME
    : VTAB 5
    : HTAB 14
    : PRINT "SURFACE MENU"

1480  LFLAG$ = FLAG$
    : FLAG$ = "SURFACE MENU"

1490  HTAB 14
    : PRINT "------------"

1500  PRINT
    : HTAB 14
    : PRINT "SHIPS"

1510  PRINT
```

```
     : HTAB 14
     : PRINT "SURFACE WEAPONS"

1520  PRINT
     : HTAB 14
     : PRINT "PROFILES"

1530  GOSUB 3220
     : REM  INPUT DISP SUB

1540  GOSUB 3700
     : REM  ANS SUB

1550  GOTO 1590

1560  STOP

1570  REM  SURF A/I PACK

1580  REM  -------------

1590  FOR I = 1 TO 3

1600    IF ANS$(I) = "SHIPS" THEN 1690

1610    IF ANS$(I) = "SURFACE WEAPONS" THEN 2190

1620    IF ANS$(I) = "PROFILES" THEN 2240

1630    IF ANS$(I) = "MAIN MENU" THEN 320

1640    IF ANS$(I) = "GO BACK" THEN 3590

1650    IF ANS$(I) = "ABORT" THEN 3150

1660  NEXT I

1670  GOTO 3350
     : REM  ERROR PACK

1680  STOP

1690  REM  SHIPS MENU

1700  REM  ----------

1710  HOME
     : VTAB 5
     : HTAB 15
     : PRINT "SHIP MENU"

1720  LFLAG$ = FLAG$
```

```
      : FLAG$ = "SHIPS"

1730  HTAB 15
      : PRINT "---------"

1740  PRINT
      : HTAB 15
      : PRINT "ALPHA - KRESTA I/II"

1750  PRINT
      : HTAB 15
      : PRINT "BRAVO - KYNDA"

1760  PRINT
      : HTAB 15
      : PRINT "CHARLIE - KARA"

1770  PRINT
      : HTAB 15
      : PRINT "DELTA - KASHIN (MOD)"

1780  GOSUB 3220
      : REM  INPUT DISP SUB

1790  GOSUB 3700
      : REM  ANS SUB

1800  GOTO 1820

1810  STOP

1820  REM  SHIPS A/I PACK

1830  REM  --------------

1840  FOR I = 1 TO 3

1850    IF ANS$(I) = "ALPHA" THEN 1970

1860    IF ANS$(I) = "BRAVO" THEN 2030

1870    IF ANS$(I) = "CHARLIE" THEN 2090

1880    IF ANS$(I) = "DELTA" THEN 2150

1890    IF ANS$(I) = "MAIN MENU" THEN 320

1900    IF ANS$(I) = "GO BACK" THEN 3590

1910    IF ANS$(I) = "ABORT" THEN 3150

1920  NEXT I
```

```
1930  GOTO 3350
    : REM  ERROR PACK

1940  STOP

1950  REM  SHIP DATA PACK

1960  REM  -------------

1970  HOME
    : VTAB 12
    : HTAB 14
    : PRINT "KRESTA DATA"

1980  GOSUB 3290
    : REM  HOLD SUB

1990  GOTO 1690
    : REM  SHIPS MENU

2000  STOP

2010  REM  KYNDA DISPLAY

2020  REM  ------------

2030  HOME
    : VTAB 12
    : HTAB 14
    : PRINT "KYNDA DISPLAY"

2040  GOSUB 3290
    : REM      HOLD SUB

2050  GOTO 1690

2060  STOP

2070  REM  KARA DISPLAY

2080  REM  -----------

2090  HOME
    : VTAB 12
    : HTAB 13
    : PRINT "KARA DISPLAY"

2100  GOSUB 3290
    : REM      HOLD SUB

2110  GOTO 1690
```

```
2120  STOP

2130  REM  KASHIN DISPLAY

2140  REM  -------------

2150  HOME
    : VTAB 12
    : HTAB 12
    : PRINT "KASHIN DISPLAY"

2160  GOSUB 3290
    : REM     HOLD SUB

2170  GOTO 1450

2180  STOP

2190  REM  SURF ASCM MENU

2200  REM  -------------

2210  MARK$ = "SURF ASCM'S"
    : GOSUB 3490
    : REM    NOT IMP SUB

2220  GOTO 1450

2230  STOP

2240  REM  SURF PROFILE MENU

2250  REM  ----------------

2260  MARK$ = "SURF PROFILES"
    : GOSUB 3490
    : REM   NOT IMP SUB

2270  GOTO 320

2280  STOP

2290  REM  SUB MENU

2300  REM  --------

2310  HOME
    : VTAB 5
    : HTAB 13
    : PRINT "SUBMARINE MENU"
```

```
2320  LFLAG$ = FLAG$
    : FLAG$ = "SUBMARINE MENU"

2330  HTAB 13
    : PRINT "--------------"

2340  PRINT
    : HTAB 13
    : PRINT "SUBMARINES"

2350  PRINT
    : HTAB 13
    : PRINT "SUBMARINE WEAPONS"

2360  PRINT
    : HTAB 13
    : PRINT "PROFILES"

2370  GOSUB 3220
    : REM  INPUT DISP SUB

2380  GOSUB 3700
    : REM  ANS SUB

2390  GOTO 2410

2400  STOP

2410  REM  SUB A/I PACK

2420  REM  ------------

2430  FOR I = 1 TO 3

2440    IF ANS$(I) = "SUBMARINES" THEN 2530

2450    IF ANS$(I) = "SUBMARINE WEAPONS" THEN 3050

2460    IF ANS$(I) = "PROFILES" THEN 3100

2470    IF ANS$(I) = "MAIN MENU" THEN 320

2480    IF ANS$(I) = "GO BACK" THEN 3590

2490    IF ANS$(I) = "ABORT" THEN 3150

2500  NEXT I

2510  GOTO 3350
    : REM  ERROR PACK

2520  STOP
```

```
2530  REM  SUBS MENU

2540  REM  ---------

2550  HOME
    : VTAB 5
    : HTAB 14
    : PRINT "SUB PLATFORMS"

2560  LFLAG$ = FLAG$
    : FLAG$ = "SUBMARINES"

2570  HTAB 14
    : PRINT "-------------"

2580  PRINT
    : HTAB 14
    : PRINT "ALPHA - H.E.N. CLASS"

2590  PRINT
    : HTAB 14
    : PRINT "BRAVO - CHARLIE"

2600  PRINT
    : HTAB 14
    : PRINT "CHARLIE - ECHO II"

2610  PRINT
    : HTAB 14
    : PRINT "DELTA - JULIETT"

2620  GOSUB 3220
    : REM  INPUT DISP SUB

2630  GOSUB 3700
    : REM  ANS SUB

2640  GOTO 2660

2650  STOP

2660  REM  SUB A/I PACK

2670  REM  ------------

2680  FOR I = 1 TO 3

2690     IF ANS$(I) = "ALPHA" THEN 2810

2700     IF ANS$(I) = "BRAVO" THEN 2870
```

```
2710     IF ANS$(I) = "CHARLIE" THEN 2930

2720     IF ANS$(I) = "DELTA" THEN 2990

2730     IF ANS$(I) = "MAIN MENU" THEN 320

2740     IF ANS$(I) = "ABORT" THEN 3150

2750     IF ANS$(I) = "GO BACK" THEN 3590

2760   NEXT I

2770   GOTO 3350
     : REM  ERROR PACK

2780   REM  SUB DATA PACK

2790   REM  -------------

2800   STOP

2810   REM  H.E.N. DISPLAY

2820   REM  --------------

2830   HOME
     : VTAB 12
     : HTAB 14
     : PRINT "H.E.N. DISPLAY"

2840   GOSUB 3290
     : REM  HOLD SUB

2850   GOTO 2530

2860   STOP

2870   REM  C/V  DISPLAY

2880   REM  ------------

2890   HOME
     : VTAB 12
     : HTAB 14
     : PRINT "C/V  DISPLAY"

2900   GOSUB 3290
     : REM  HOLD SUB

2910   GOTO 2530

2920   STOP
```

```
2930  REM  ECHO II DISPLAY

2940  REM  --------------

2950  HOME
    : VTAB 12
    : HTAB 13
    : PRINT "ECHO II DISPLAY"

2960  GOSUB 3290
    : REM  HOLD SUB

2970  GOTO 2530

2980  STOP

2990  REM  JULIET DISPLAY

3000  REM  -------------

3010  HOME
    : VTAB 12
    : HTAB 12
    : PRINT "JULIET DISPLAY"

3020  GOSUB 3290
    : REM  HOLD SUB

3030  GOTO 2290

3040  STOP

3050  REM  SUB ASCM MENU

3060  REM  ------------

3070  MARK$ = "SUB ASCM'S"
    : GOSUB 3490
    : REM   NOT IMP SUB

3080  GOTO 2290

3090  STOP

3100  REM  SUBMARINE PROFILE MENU

3110  REM  ---------------------

3120  MARK$ = "SUB PROFILES"
    : GOSUB 3490
    : REM   NOT IMP SUB
```

```
3130  GOTO 610

3140  STOP

3150  REM  ABORT PACKAGE

3160  REM  ------------

3170  VTAB 1
    : FOR I = 0 TO 38
    :   PRINT " ";
    : NEXT I
    : PRINT " "

3180  VTAB 1
    : PRINT "F.S. CALCATERRA"; SPC( 8);"THESIS DISK #001"

3190  VTAB 5
    : HOME
    : VTAB 12
    : HTAB 12
    : FLASH
    : PRINT "PROGRAM ABORTED"
    : NORMAL

3200  VTAB 20
    : HTAB 13
    : PRINT "ERROR TOTAL=";ET

3210  VTAB 23
    : GOTO 3770
    : REM      END

3220  REM  INPUT DISPLAY SUBROUTINE

3230  REM  ----------------------

3240  VTAB 1
    : FOR I = 0 TO 38
    :   PRINT " ";
    : NEXT I
    : PRINT " "

3250  VTAB 1
    : PRINT "ABORT"; SPC( 9);"GO BACK"; SPC( 9);"MAIN MEN
        U"

3260  VTAB 23
    : FOR I = 0 TO 38
    :   PRINT " ";
    : NEXT I
```

```
    : PRINT " "

3270  VTAB 23
    : PRINT SPC( 8);"WHAT IS YOUR CHOICE ?";

3280  RETURN

3290  REM  HOLD SUBROUTINE

3300  REM  --------------

3310  VTAB 1
    : FOR I = 0 TO 38
    :   PRINT " ";
    : NEXT I
    : PRINT " "

3320  VTAB 23
    : FOR I = 0 TO 38
    :   PRINT " ";
    : NEXT I
    : PRINT " "

3330  VTAB 23
    : HTAB 14
    : PRINT "PLEASE WAIT";
    : FOR TD = 1 TO 1000
    : NEXT TD
    : REM     TIME DELAY

3340  RETURN

3350  REM  ERROR PACKAGE

3360  REM  ------------

3370  ET = ET + 1

3380  HOME
    : VTAB 01
    : FOR I = 0 TO 38
    :   PRINT " ";
    : NEXT I
    : PRINT " "

3390  VTAB 01
    : PRINT SPC( 17);"ERROR"

3400  VTAB 23
    : HTAB 8
    : PRINT "PRESS ANY KEY TO CONTINUE   ";
    : GET A$
```

```
3410  IF FLAG$ = "MAIN MENU" THEN 320

3420  IF FLAG$ = "AIRCRAFT MENU" THEN 610

3430  IF FLAG$ = "ATTACK AIR" THEN 850

3440  IF FLAG$ = "SURFACE MENU" THEN 1450

3450  IF FLAG$ = "SHIPS" THEN 1690

3460  IF FLAG$ = "SUBMARINE MENU" THEN 2290

3470  IF FLAG$ = "SUBMARINES" THEN 2530

3480  HOME
    : VTAB 10
    : HTAB 15
    : FLASH
    : PRINT "FATAL ERROR"
    : NORMAL
    : STOP

3490  REM  NOT IMPLEMENTED SUBROUTINE

3500  REM  -------------------------

3510  HOME

3520  VTAB 1
    : FOR I = 0 TO 38
    :   PRINT " ";
    : NEXT I
    : PRINT " "

3530  VTAB 01
    : HTAB 13
    : PRINT "NOT IMPLEMENTED"

3540  VTAB 12
    : HTAB 15
    : PRINT MARK$

3550  VTAB 22
    : HTAB 15
    : FLASH

3560  PRINT "PLEASE WAIT"
    : NORMAL

3570  FOR TD = 1 TO 1000
    : NEXT TD
```

```
       : REM       DELAY

3580   RETURN

3590   REM   BACK PACKAGE

3600   REM   ------------

3610   IF LFLAG$ = "NULL" THEN 320

3620   IF LFLAG$ = "MAIN MENU" THEN 320

3630   IF LFLAG$ = "AIRCRAFT MENU" THEN 610

3640   IF LFLAG$ = "ATTACK AIR" THEN 850

3650   IF LFLAG$ = "SURFACE MENU" THEN 1450

3660   IF LFLAG$ = "SHIPS" THEN 1690

3670   IF LFLAG$ = "SUBMARINE MENU" THEN 2290

3680   IF LFLAG$ = "SUBMARINES" THEN 2530

3690   HOME
     : VTAB 12
     : HTAB 14
     : FLASH
     : PRINT "FATAL ERROR"
     : NORMAL
     : STOP

3700   REM   ANSWER SUBROUTINE

3710   REM   -----------------

3720   REM       NO A/I

3730   ANS$(1) = "TEST ONE"
     : ANS$(2) = "TEST TWO"

3740   GOSUB 4080
     : REM    GET VOICE ANSWER

3760   IF SREC$ < > "?" THEN 3790

3770   VTAB 22
     : INVERSE
     : PRINT
     : PRINT "   PLEASE REPEAT ";
     : NORMAL
```

```
3780  GOTO 3740

3790  ANS$(3) = SREC$

3800  RETURN

3810  END

3820  REM      **** VET2 INITIALIZATION ****

3830  BASEA = - 25346

3840  ADLST = PEEK (BASEA) + 256 * PEEK (BASEA + 1) - 6553
        6

3850  JTABLE = PEEK (BASEA - 2) + 256 * PEEK (BASEA - 1) -
        65536

3860  PARBASE = PEEK (ADLST) + 256 * PEEK (ADLST + 1) - 65
        536

3870  RETURN

3880  REM      **** VET2 VOCABULARY READ ****

3890  X% = LEN (VOC$)

3900  IF X% = 0 THEN RETURN

3910  POKE (PARBASE + 1),X%

3920  FOR ZXZ = 1 TO X%

3930    POKE (PARBASE + 1 + ZXZ), ASC ( MID$ (VOC$,ZXZ,1))

3940  NEXT ZXZ

3950  CALL JTABLE + 6

3960  RETURN

3970  REM      **** VET2 SYNTAX SET/RESET ****

3980  IF LEN (SYN$) < 2 THEN RETURN

3990  X% = ASC (SYN$)
    : SXX$ = MID$ (SYN$,2)

4000  POKE PARBASE,X% - ASC ("0")

4010  X% = LEN (SXX$)
```

```
4020  POKE (PARBASE + 1),X%
4030  FOR ZXZ = 1 TO X%
4040    POKE (PARBASE + 1 + ZXZ), ASC ( MID$ (SXX$,ZXZ,1))
4050  NEXT ZXZ
4060  CALL JTABLE + 3
4070  RETURN
4080  REM      **** VET2 RECOGNITION ****
4090  CALL JTABLE
4100  X% = PEEK (PARBASE + 1)
4110  SREC$ = ""
4120  FOR ZXZ = 1 TO X%
4130    SREC$ = SREC$ + CHR$ ( PEEK (PARBASE + 1 + ZXZ))
4140  NEXT ZXZ
4150  RETURN
4160  REM      **********************
```

APPENDIX C

PROGRAM TWO (ENHANCED A.I.)

```
110   REM      VET INTERFACE PACKAGE

120   REM      --------------------

130   GOSUB 3820
    : REM  VET INITIALIZE

140   CALL JTABLE + 15

150   REM     GOTO 240 SKIPS LOAD

160   HOME
    : VTAB 10

170   INPUT "VOICE FILE NAME ... ";VOC$

180   GOSUB 3880
    : REM      READ VOICE FILE

190   SYN$ = "2X"
    : REM      TURN OFF X-WORDS

200   GOSUB 3970
    : REM      EXECUTE SYN$ ABOVE

210   REM  END VET INTERFACE PACK

220   REM  ---------------------

230   REM

240   REM

250   REM  F.S.CALCATERRA 12/10

260   REM  ====================

270   REM

280   REM  -------------------

290   REM  * MAIN MENU MODULE *

300   REM  -------------------

310   REM

320   REM  MAIN MENU
```

```
330   REM  ---------

340   TEXT
    : HOME
    : POKE 44611,1

350   PRINT "F.S. CALCATERRA"; SPC( 8);"THESIS DISK #001"

360   FOR I = 1 TO 38
    :   PRINT ".";
    : NEXT I
    : PRINT "."

370   POKE 34,2

380   HOME
    : VTAB 5
    : HTAB 14

390   PRINT "MAIN MENU"

400   FLAG$ = "MAIN MENU"
    : LFLAG$ = "NULL"

410   HTAB 14
    : PRINT "---------"

420   PRINT
    : HTAB 14
    : PRINT "AIRCRAFT MENU"

430   PRINT
    : HTAB 14
    : PRINT "SURFACE MENU"

440   PRINT
    : HTAB 14
    : PRINT "SUBMARINE MENU"

450   GOSUB 3220
    : REM  INPUT DISPLAY SUB

460   GOSUB 3700
    : REM  ANS SUB

470   GOTO 490

480   STOP

490   REM  MAIN MENU A/I PACK

500   REM  -----------------
```

```
510   FOR I = 1 TO 3
520     IF ANS$(I) = "AIRCRAFT MENU" THEN 610
530     IF ANS$(I) = "SURFACE MENU" THEN 1450
540     IF ANS$(I) = "SUBMARINE MENU" THEN 2290
550     IF ANS$(I) = "GO BACK" THEN 3590
560     IF ANS$(I) = "ABORT" THEN 3150
570     IF ANS$(I) = "MAIN MENU" THEN 320
580   NEXT I
590   GOTO 3350
    : REM  ERROR PACK
600   STOP
610   REM  AIR MENU
620   REM  --------
630   HOME
    : VTAB 5
    : HTAB 14
    : PRINT "AIRCRAFT MENU"
640   LFLAG$ = FLAG$
    : FLAG$ = "AIRCRAFT MENU"
650   HTAB 14
    : PRINT "-------------"
660   PRINT
    : HTAB 14
    : PRINT "ATTACK AIR"
670   PRINT
    : HTAB 14
    : PRINT "AIR WEAPONS"
680   PRINT
    : HTAB 14
    : PRINT "PROFILES"
690   GOSUB 3220
    : REM  INPUT DISP SUB
```

```
700   GOSUB 3700
    : REM  ANS SUB

710   GOTO 730

720   STOP

730   REM  AIR A/I PACK

740   REM  ------------

750   FOR I = 1 TO 3

760     IF ANS$(I) = "ATTACK AIR" THEN 850

770     IF ANS$(I) = "AIR WEAPONS" THEN 1350

780     IF ANS$(I) = "PROFILES" THEN 1400

790     IF ANS$(I) = "MAIN MENU" THEN 320

800     IF ANS$(I) = "ABORT" THEN 3150

810     IF ANS$(I) = "GO BACK" THEN 3590

820   NEXT I

830   GOTO 3350
    : REM  ERROR PACK

840   STOP

850   REM  AIRPLANES MENU

860   REM  --------------

870   HOME
    : VTAB 5
    : HTAB 13
    : PRINT "ATTACK AIRCRAFT"

880   LFLAG$ = FLAG$
    : FLAG$ = "ATTACK AIR"

890   HTAB 13
    : PRINT "---------------"

900   PRINT
    : HTAB 13
    : PRINT "ALPHA  - BADGER"

910   PRINT
```

```
    : HTAB 13
    : PRINT "BRAVO - BEAR"

920   PRINT
    : HTAB 13
    : PRINT "CHARLIE - BLINDER"

930   PRINT
    : HTAB 13
    : PRINT "DELTA - BACKFIRE"

940   GOSUB 3220
    : REM  INPUT DISP SUB

950   GOSUB 3700
    : REM  ANS SUB

960   GOTO 980

970   STOP

980   REM  ATTAIR A/I PACK

990   REM  ---------------

1000  FOR I = 1 TO 3

1010    IF ANS$(I) = "ALPHA" THEN 1110

1020    IF ANS$(I) = "BRAVO" THEN 1170

1030    IF ANS$(I) = "CHARLIE" THEN 1230

1040    IF ANS$(I) = "DELTA" THEN 1290

1050    IF ANS$(I) = "MAIN MENU" THEN 320

1060    IF ANS$(I) = "ABORT" THEN 3150

1070    IF ANS$(I) = "GO BACK" THEN 3590

1080  NEXT I

1090  GOTO 3350
    : REM  ERROR PACK

1100  STOP

1110  REM  BADGER DISPLAY

1120  REM  --------------
```

```
1130  HOME
    : VTAB 12
    : HTAB 14
    : PRINT "BADGER DATA"

1140  GOSUB 3290
    : REM  HOLD SUB

1150  GOTO 850

1160  STOP

1170  REM  BEAR DISPLAY

1180  REM  ------------

1190  HOME
    : VTAB 12
    : HTAB 14
    : PRINT "BEAR DISPLAY"

1200  GOSUB 3290
    : REM  HOLD SUB

1210  GOTO 850

1220  STOP

1230  REM  BLINDER DISPLAY

1240  REM  ---------------

1250  HOME
    : VTAB 12
    : HTAB 13
    : PRINT "BLINDER DISPLAY"

1260  GOSUB 3290
    : REM  HOLD SUB

1270  GOTO 850

1280  STOP

1290  REM  BACKFIRE DISPLAY

1300  REM  ----------------

1310  HOME
    : VTAB 12
    : HTAB 12
    : PRINT "BACKFIRE DISPLAY"
```

```
1320  GOSUB 3290
     : REM      HOLD SUB

1330  GOTO 610

1340  STOP

1350  REM  AIR ASCM MENU

1360  REM  ------------

1370  MARK$ = "AIR ASCM"
     : GOSUB 3490
     : REM  NOT IMP SUB

1380  GOTO 610

1390  STOP

1400  REM  AIR PROFILE MENU

1410  REM  ---------------

1420  MARK$ = "AIR PROFILES"
     : GOSUB 3490
     : REM  NOT IMP SUB

1430  GOTO 320

1440  STOP

1450  REM  SURFACE MENU

1460  REM  -----------

1470  HOME
     : VTAB 5
     : HTAB 14
     : PRINT "SURFACE MENU"

1480  LFLAG$ = FLAG$
     : FLAG$ = "SURFACE MENU"

1490  HTAB 14
     : PRINT "------------"

1500  PRINT
     : HTAB 14
     : PRINT "SHIPS"

1510  PRINT
```

```
     : HTAB 14
     : PRINT "SURFACE WEAPONS"

1520  PRINT
     : HTAB 14
     : PRINT "PROFILES"

1530  GOSUB 3220
     : REM  INPUT DISP SUB

1540  GOSUB 3700
     : REM  ANS SUB

1550  GOTO 1590

1560  STOP

1570  REM  SURF A/I PACK

1580  REM  -------------

1590  FOR I = 1 TO 3

1600    IF ANS$(I) = "SHIPS" THEN 1690

1610    IF ANS$(I) = "SURFACE WEAPONS" THEN 2190

1620    IF ANS$(I) = "PROFILES" THEN 2240

1630    IF ANS$(I) = "MAIN MENU" THEN 320

1640    IF ANS$(I) = "GO BACK" THEN 3590

1650    IF ANS$(I) = "ABORT" THEN 3150

1660  NEXT I

1670  GOTO 3350
     : REM  ERROR PACK

1680  STOP

1690  REM  SHIPS MENU

1700  REM  ----------

1710  HOME
     : VTAB 5
     : HTAB 15
     : PRINT "SHIP MENU"

1720  LFLAG$ = FLAG$
```

```
     : FLAG$ = "SHIPS"

1730  HTAB 15
     : PRINT "---------"

1740  PRINT
     : HTAB 15
     : PRINT "ALPHA - KRESTA I/II"

1750  PRINT
     : HTAB 15
     : PRINT "BRAVO - KYNDA"

1760  PRINT
     : HTAB 15
     : PRINT "CHARLIE - KARA"

1770  PRINT
     : HTAB 15
     : PRINT "DELTA - KASHIN (MOD)"

1780  GOSUB 3220
     : REM  INPUT DISP SUB

1790  GOSUB 3700
     : REM  ANS SUB

1800  GOTO 1820

1810  STOP

1820  REM  SHIPS A/I PACK

1830  REM  --------------

1840  FOR I = 1 TO 3

1850    IF ANS$(I) = "ALPHA" THEN 1970

1860    IF ANS$(I) = "BRAVO" THEN 2030

1870    IF ANS$(I) = "CHARLIE" THEN 2090

1880    IF ANS$(I) = "DELTA" THEN 2150

1890    IF ANS$(I) = "MAIN MENU" THEN 320

1900    IF ANS$(I) = "GO BACK" THEN 3590

1910    IF ANS$(I) = "ABORT" THEN 3150

1920  NEXT I
```

```
1930  GOTO 3350
    : REM  ERROR PACK

1940  STOP

1950  REM  SHIP DATA PACK

1960  REM  -------------

1970  HOME
    : VTAB 12
    : HTAB 14
    : PRINT "KRESTA DATA"

1980  GOSUB 3290
    : REM  HOLD SUB

1990  GOTO 1690
    : REM  SHIPS MENU

2000  STOP

2010  REM  KYNDA DISPLAY

2020  REM  ------------

2030  HOME
    : VTAB 12
    : HTAB 14
    : PRINT "KYNDA DISPLAY"

2040  GOSUB 3290
    : REM     HOLD SUB

2050  GOTO 1690

2060  STOP

2070  REM  KARA DISPLAY

2080  REM  -----------

2090  HOME
    : VTAB 12
    : HTAB 13
    : PRINT "KARA DISPLAY"

2100  GOSUB 3290
    : REM     HOLD SUB

2110  GOTO 1690
```

```
2120  STOP

2130  REM  KASHIN DISPLAY

2140  REM  -------------

2150  HOME
    : VTAB 12
    : HTAB 12
    : PRINT "KASHIN DISPLAY"

2160  GOSUB 3290
    : REM     HOLD SUB

2170  GOTO 1450

2180  STOP

2190  REM  SURF ASCM MENU

2200  REM  --------------

2210  MARK$ = "SURF ASCM'S"
    : GOSUB 3490
    : REM    NOT IMP SUB

2220  GOTO 1450

2230  STOP

2240  REM  SURF PROFILE MENU

2250  REM  -----------------

2260  MARK$ = "SURF PROFILES"
    : GOSUB 3490
    : REM   NOT IMP SUB

2270  GOTO 320

2280  STOP

2290  REM  SUB MENU

2300  REM  --------

2310  HOME
    : VTAB 5
    : HTAB 13
    : PRINT "SUBMARINE MENU"
```

```
2320  LFLAG$ = FLAG$
    : FLAG$ = "SUBMARINE MENU"

2330  HTAB 13
    : PRINT "--------------"

2340  PRINT
    : HTAB 13
    : PRINT "SUBMARINES"

2350  PRINT
    : HTAB 13
    : PRINT "SUBMARINE WEAPONS"

2360  PRINT
    : HTAB 13
    : PRINT "PROFILES"

2370  GOSUB 3220
    : REM  INPUT DISP SUB

2380  GOSUB 3700
    : REM  ANS SUB

2390  GOTO 2410

2400  STOP

2410  REM  SUB A/I PACK

2420  REM  ------------

2430  FOR I = 1 TO 3

2440    IF ANS$(I) = "SUBMARINES" THEN 2530

2450    IF ANS$(I) = "SUBMARINE WEAPONS" THEN 3050

2460    IF ANS$(I) = "PROFILES" THEN 3100

2470    IF ANS$(I) = "MAIN MENU" THEN 320

2480    IF ANS$(I) = "GO BACK" THEN 3590

2490    IF ANS$(I) = "ABORT" THEN 3150

2500  NEXT I

2510  GOTO 3350
    : REM  ERROR PACK

2520  STOP
```

```
2530  REM  SUBS MENU

2540  REM  ---------

2550  HOME
    : VTAB 5
    : HTAB 14
    : PRINT "SUB PLATFORMS"

2560  LFLAG$ = FLAG$
    : FLAG$ = "SUBMARINES"

2570  HTAB 14
    : PRINT "-------------"

2580  PRINT
    : HTAB 14
    : PRINT "ALPHA - H.E.N. CLASS"

2590  PRINT
    : HTAB 14
    : PRINT "BRAVO - CHARLIE"

2600  PRINT
    : HTAB 14
    : PRINT "CHARLIE - ECHO II"

2610  PRINT
    : HTAB 14
    : PRINT "DELTA - JULIETT"

2620  GOSUB 3220
    : REM  INPUT DISP SUB

2630  GOSUB 3700
    : REM  ANS SUB

2640  GOTO 2660

2650  STOP

2660  REM  SUB A/I PACK

2670  REM  ------------

2680  FOR I = 1 TO 3

2690    IF ANS$(I) = "ALPHA" THEN 2810

2700    IF ANS$(I) = "BRAVO" THEN 2870
```

```
2710     IF ANS$(I) = "CHARLIE" THEN 2930

2720     IF ANS$(I) = "DELTA" THEN 2990

2730     IF ANS$(I) = "MAIN MENU" THEN 320

2740     IF ANS$(I) = "ABORT" THEN 3150

2750     IF ANS$(I) = "GO BACK" THEN 3590

2760   NEXT I

2770   GOTO 3350
     : REM  ERROR PACK

2780   REM  SUB DATA PACK

2790   REM  ------------

2800   STOP

2810   REM  H.E.N. DISPLAY

2820   REM  -------------

2830   HOME
     : VTAB 12
     : HTAB 14
     : PRINT "H.E.N. DISPLAY"

2840   GOSUB 3290
     : REM  HOLD SUB

2850   GOTO 2530

2860   STOP

2870   REM  C/V  DISPLAY

2880   REM  -----------

2890   HOME
     : VTAB 12
     : HTAB 14
     : PRINT "C/V  DISPLAY"

2900   GOSUB 3290
     : REM  HOLD SUB

2910   GOTO 2530

2920   STOP
```

```
2930  REM  ECHO II DISPLAY

2940  REM  ---------------

2950  HOME
     : VTAB 12
     : HTAB 13
     : PRINT "ECHO II DISPLAY"

2960  GOSUB 3290
     : REM  HOLD SUB

2970  GOTO 2530

2980  STOP

2990  REM  JULIET DISPLAY

3000  REM  --------------

3010  HOME
     : VTAB 12
     : HTAB 12
     : PRINT "JULIET DISPLAY"

3020  GOSUB 3290
     : REM  HOLD SUB

3030  GOTO 2290

3040  STOP

3050  REM  SUB ASCM MENU

3060  REM  -------------

3070  MARK$ = "SUB ASCM'S"
     : GOSUB 3490
     : REM   NOT IMP SUB

3080  GOTO 2290

3090  STOP

3100  REM  SUBMARINE PROFILE MENU

3110  REM  ----------------------

3120  MARK$ = "SUB PROFILES"
     : GOSUB 3490
     : REM   NOT IMP SUB
```

```
3130  GOTO 610

3140  STOP

3150  REM  ABORT PACKAGE

3160  REM  ------------

3170  VTAB 1
    : FOR I = 0 TO 38
    :   PRINT " ";
    : NEXT I
    : PRINT " "

3180  VTAB 1
    : PRINT "F.S. CALCATERRA"; SPC( 8);"THESIS DISK #001"

3190  VTAB 5
    : HOME
    : VTAB 12
    : HTAB 12
    : FLASH
    : PRINT "PROGRAM ABORTED"
    : NORMAL

3200  VTAB 20
    : HTAB 13
    : PRINT "ERROR TOTAL=";ET

3210  VTAB 23
    : GOTO 3775
    : REM  END

3220  REM  INPUT DISPLAY SUBROUTINE

3230  REM  ----------------------

3240  VTAB 1
    : FOR I = 0 TO 38
    :   PRINT " ";
    : NEXT I
    : PRINT " "

3250  VTAB 1
    : PRINT "ABORT"; SPC( 9);"GO BACK"; SPC( 9);"MAIN MEN
       U"

3260  VTAB 23
    : FOR I = 0 TO 38
    :   PRINT " ";
    : NEXT I
```

```
     : PRINT " "

3270  VTAB 23
     : PRINT SPC( 8);"WHAT IS YOUR CHOICE ?";

3280  RETURN

3290  REM  HOLD SUBROUTINE

3300  REM  ---------------

3310  VTAB 1
     : FOR I = 0 TO 38
     :   PRINT " ";
     : NEXT I
     : PRINT " "

3320  VTAB 23
     : FOR I = 0 TO 38
     :   PRINT " ";
     : NEXT I
     : PRINT " "

3330  VTAB 23
     : HTAB 14
     : PRINT "PLEASE WAIT";
     : FOR TD = 1 TO 1000
     : NEXT TD
     : REM     TIME DELAY

3340  RETURN

3350  REM  ERROR PACKAGE

3360  REM  -------------

3370  ET = ET + 1

3380  HOME
     : VTAB 01
     : FOR I = 0 TO 38
     :   PRINT " ";
     : NEXT I
     : PRINT " "

3390  VTAB 01
     : PRINT SPC( 17);"ERROR"

3395  VTAB 12
     : FOR I = 1 TO 3
     :   PRINT ANS$(I)
     : NEXT I
```

```
3400  VTAB 23
    : HTAB 8
    : PRINT "PRESS ANY KEY TO CONTINUE   ";
    : GET A$

3410  IF FLAG$ = "MAIN MENU" THEN 320

3420  IF FLAG$ = "AIRCRAFT MENU" THEN 610

3430  IF FLAG$ = "ATTACK AIR" THEN 850

3440  IF FLAG$ = "SURFACE MENU" THEN 1450

3450  IF FLAG$ = "SHIPS" THEN 1690

3460  IF FLAG$ = "SUBMARINE MENU" THEN 2290

3470  IF FLAG$ = "SUBMARINES" THEN 2530

3480  HOME
    : VTAB 10
    : HTAB 15
    : FLASH
    : PRINT "FATAL ERROR"
    : NORMAL
    : STOP

3490  REM  NOT IMPLEMENTED SUBROUTINE

3500  REM  -------------------------

3510  HOME

3520  VTAB 1
    : FOR I = 0 TO 38
    :   PRINT " ";
    : NEXT I
    : PRINT " "

3530  VTAB 01
    : HTAB 13
    : PRINT "NOT IMPLEMENTED"

3540  VTAB 12
    : HTAB 15
    : PRINT MARK$

3550  VTAB 22
    : HTAB 15
    : FLASH
```

```
3560  PRINT "PLEASE WAIT"
    : NORMAL

3570  FOR TD = 1 TO 1000
    : NEXT TD
    : REM      DELAY

3580  RETURN

3590  REM  BACK PACKAGE

3600  REM  ------------

3610  IF LFLAG$ = "NULL" THEN 320

3620  IF LFLAG$ = "MAIN MENU" THEN 320

3630  IF LFLAG$ = "AIRCRAFT MENU" THEN 610

3640  IF LFLAG$ = "ATTACK AIR" THEN 850

3650  IF LFLAG$ = "SURFACE MENU" THEN 1450

3660  IF LFLAG$ = "SHIPS" THEN 1690

3670  IF LFLAG$ = "SUBMARINE MENU" THEN 2290

3680  IF LFLAG$ = "SUBMARINES" THEN 2530

3690  HOME
    : VTAB 12
    : HTAB 14
    : FLASH
    : PRINT "FATAL ERROR"
    : NORMAL
    : STOP

3700  REM  AI ANSWER SUBROUTINE

3703  REM  ====================

3706  GOSUB 4080

3712  IF XFLAG = 1 THEN 3736

3715  DIM WV(20),W$(20)

3718  FOR J = 0 TO 16
    :   READ W$(J)
    : NEXT J

3721  XFLAG = 1
```

```
3724  DATA  MAIN MENU,AIRCRAFT MENU,SURFACE MENU,SUBMARINE
          MENU,GO BACK

3727  DATA    ABORT,ATTACK AIR,AIR WEAPONS,PROFILES,ALPHA

3730  DATA    BRAVO,CHARLIE,DELTA,SHIPS,SURFACE WEAPONS

3733  DATA      SUBMARINES,SUBMARINE WEAPONS

3736  FOR K = 0 TO 1921 STEP 113

3739    WV(K / 113) = PEEK (29818 + K) + 256 * PEEK (29819
           + K)
    : NEXT K

3742  FOR L = 1 TO 3

3745    SM = WV(0)
    :   TAK = 0

3748    FOR M = 0 TO 16

3751      IF SM > WV(M) THEN 3757

3754      GOTO 3760

3757      SM = WV(M)
    :     TAK = M

3760    NEXT M

3763    WV(TAK) = 9999

3766    ANS$(L) = W$(TAK)

3769  NEXT L

3772  RETURN

3775  END

3810  END

3820  REM      **** VET2 INITIALIZATION ****

3830  BASEA = - 25346

3840  ADLST = PEEK (BASEA) + 256 * PEEK (BASEA + 1) - 6553
        6

3850  JTABLE = PEEK (BASEA - 2) + 256 * PEEK (BASEA - 1) -
```

```
65536
3860  PARBASE = PEEK (ADLST) + 256 * PEEK (ADLST + 1) - 65
        536
3870  RETURN
3880  REM       **** VET2 VOCABULARY READ ****
3890  X% = LEN (VOC$)
3900  IF X% = 0 THEN RETURN
3910  POKE (PARBASE + 1),X%
3920  FOR ZXZ = 1 TO X%
3930    POKE (PARBASE + 1 + ZXZ), ASC ( MID$ (VOC$,ZXZ,1))
3940  NEXT ZXZ
3950  CALL JTABLE + 6
3960  RETURN
3970  REM       **** VET2 SYNTAX SET/RESET ****
3980  IF LEN (SYN$) < 2 THEN RETURN
3990  X% = ASC (SYN$)
    : SXX$ = MID$ (SYN$,2)
4000  POKE PARBASE,X% - ASC ("0")
4010  X% = LEN (SXX$)
4020  POKE (PARBASE + 1),X%
4030  FOR ZXZ = 1 TO X%
4040    POKE (PARBASE + 1 + ZXZ), ASC ( MID$ (SXX$,ZXZ,1))
4050  NEXT ZXZ
4060  CALL JTABLE + 3
4070  RETURN
4080  REM       **** VET2 RECOGNITION ****
4090  CALL JTABLE
```

```
4100  X% = PEEK (PARBASE + 1)
4110  SREC$ = ""
4120  FOR ZXZ = 1 TO X%
4130    SREC$ = SREC$ + CHR$ ( PEEK (PARBASE + 1 + ZXZ))
4140  NEXT ZXZ
4150  RETURN
4160  REM       **********************
```

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